A MATCHED-SIDE COMPARATIVE STUDY OF THE UNSPLIT BLUE STOCK AND CRUST LEATHER MADE FROM UNCURED AND PIT-CURED HIDES*

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ABSTRACT

A matched-side study of 300 heavy steerhides was conducted jointly by Spencer Foods, Inc.†† and two agencies of the USDA to reexamine the economics of processing fresh, uncured hides into side upper leather in the light of efforts being made to eliminate salt from tannery and packing house effluents. In this report we present a comparison of the chemical and physical properties of leather made from uncured *vs.* cured sides at the wrung, unsplit blue stage and again at the dry crust stage, designed to indicate any potential quality advantage of one type of product over the other. A further effort was made to determine whether any other commercially important differences occurred, in response to processing, between the two types of stock. Analysis of the blue stock revealed that the uncured sides had a significantly higher chrome and ash content and a higher shrinkage temperature, while microscopic examination showed no difference in chrome distribution or extent of opening up of the fibers. Physical tests showed a higher tensile strength and penetrometer strength for the uncured sides but a lower ball burst extension value. The crust leather from uncured sides was equivalent to that from cured sides in sorting characteristics but had a significantly higher tensile strength. Processing differences were noted at the liming and chrome-tanning steps that appear advantageous to the processing of fresh hides. Furthermore, there was a slightly higher yield of crust leather from the uncured sides. It was concluded that it is possible, and perhaps economically advantageous, to process uncured

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††Reference to brand or firm name does not constitute endorsement by the U. S. Department of Agriculture over others of a similar nature not mentioned.

hides by conventional processes into quality leather that is essentially indistinguishable from leather made from cured hides.

INTRODUCTION

The desirability of eliminating the use of salt in the curing of hides was recognized some time ago and research concerning this problem has been in progress for several years. One approach has been to develop alternative methods for preserving hides. Some progress has been made along these lines and the subject has been reviewed recently (1, 2). A second approach has been to process uncured hides. This approach, of course, places very stringent limitations upon the location of a tannery with respect to its source of uncured hides. For certain tanneries these limitations have been met and some uncured hides are currently being processed. An alternative that is being seriously considered (3) is for hide processors to process the uncured hides to wet blue stock (or perhaps to crust leather) and to market these products to specialized finishing companies. Both alternatives call for the direct processing of uncured hides, while the second alternative also involves the marketing of a semiprocessed product. These two considerations, the processing of uncured hides and the marketing of semiprocessed leather, led to the research reported here.

One of the basic questions which the research was designed to answer concerned the quality of the leather that could be made from uncured hides. Much has been said and written, both favorably (4) and unfavorably (5, 6), concerning the subject. The present study has supplied an answer to this question. A second question concerned processing differences and this study revealed that there are some that should be recognized and perhaps used to advantage. A third question concerned the marketing of new products, wet blue stock and/or crust leather, for example, and the desirability of establishing standards by which to judge the quality of these new products. This remains a major problem area facing the industry and work is in progress at our laboratory and in other locations (7) in a search for the answers.

Of course, a major consideration underlying all of the above is the economic impact. This consideration has been thoroughly analyzed as a part of the overall study and was reported separately (3).

TECHNICAL INFORMATION

Three hundred freshly flayed, butt-branded, heavy steer hides were washed, fleshed, demanured, and trimmed in the normal manner by personnel of Spencer Foods, Inc., Spencer, Iowa. They were then sided, labeled, and weighed by USDA personnel who placed alternate left and right sides into two lots. One lot was transported by truck immediately to Spencer Leather Division of Spencer Foods, Inc., Milwaukee, Wisconsin, where it was processed within 24 hrs. of flaying. The other lot was pit-cured, held for four days, and then also transported by truck to the same tannery for processing. The uncured lot was put into soak on the day after flaying and the cured lot was put into soak on the fifth day after flaying. The weights of the two packs at the time they were made up (calculated by actual side weights) and on their arrival at the tannery (measured on the whole packs) are given in Table I.

TABLE I

PACK AND AVERAGE SIDE WEIGHTS AT DIFFERENT STAGES OF PROCESSING

	Cured Sides (304)		Uncured Sides (296)	
	Pack (lbs.)	Per Side (lbs.)	Pack (lbs.)	Per Side (lbs.)
Original packer lots	10066	33.1	9834	33.2
Received at tannery	8975	29.5	9680	32.7
White (limed)	13895	45.7	12355	41.7
Wet blue (tanned)	9670	31.8	9405	31.8
Wrung blue	7560	24.9	7514	25.4

The total processes through the tannage for the two packs took 50 to 55 hrs., 36 hrs. of which were spent for reliming. The two processes were essentially the same. The exceptions were a longer soak (five hrs.) for the cured pack and the addition of extra white stock to the uncured pack in order to make the required drum load prior to the bate, pickle, and tan steps. The pack weights at different points through the processing are given in Table I. The side count at the end of processing revealed that there were 304 sides in the cured lot and 296 in the uncured lot, a discrepancy that was caused by an error in placement of four sides at the time of siding, labeling, and weighing. The blue stock from both lots stood a three-min. boil and the pH of the exhaust tan liquor was 3.4–3.5.

Both lots were sorted by the tannery's experienced blue sorter and then 18 pairs of sides (preselected randomly by number) were sampled in the official butt position for analysis and physical testing (8). The two lots were then split and shaved, retanned, colored and fatliquored, paste-dried, and staked to give a 5½ oz. unlined-boot crust leather. The same 18 pairs of sides were again sampled in an adjacent area for physical testing at this stage of processing.

RESULTS AND DISCUSSION

Processing

Some observations which were made by tannery personnel prior to, during, and after processing are of significance to the results. First, the lot of cured sides was observed to be "damper" than usual upon arrival at the tannery and it was learned that this lot had been exposed to a rain storm in an unprotected condition during loading onto the truck. This is obviously the reason for the apparent low loss in weight (11 percent) during curing (see Table I). These cured sides were prematurely (by about 12 hrs.) rewet; this does not reflect on the adequacy of the cure. Second, the limed sides from the cured lot were observed to be more drawn than, and not as clear as, the sides from the uncured lot.

The cured lot of sides had a white weight very close to 14,000 lbs., which was the pack weight regularly used by this tannery for their bate-pickle-tan steps, and was therefore used as such. The uncured lot of sides had a significantly lower white weight — 12,355 lbs. — and therefore additional limed stock (1,645 lbs. of limed whole hides) was added to reach the desired weight. Of course, the original amount of hide substance in the two lots was essentially the same (within three percent) so that this smaller increase in weight must be associated with the interaction of the uncured stock with the lime and resulted in a lower weight gain than was obtained with the cured stock. The weight of hide substance, after removal of the added whole hides, was still obviously the same, since, after tanning and wringing, the weights of the two lots were again very close (Table I). These points are perhaps best comprehended from the calculated average side weights in Table I, where the differences caused by the different numbers of sides in the two lots are eliminated.

The unanticipated weight difference between the two lots at the white stage resulted in a difference in the amount of tanning agent offered to the two lots when this amount is calculated either on a per-side or hide-substance basis. On the latter basis, there was about 12 percent more hide substance present in the pack of uncured sides made up for the bate-pickle-tan steps than there was in the pack containing the cured sides. However, the same amounts of chemicals, including tanning agent, were used for both packs and yet, as we shall see, the tanned sides from the uncured lot had a significantly higher Cr_2O_3 content. There exists a potential for savings in materials resulting from these observed processing differences.

Blue Sort

At blue sort 252 pairs of matched sides were positively identified, and the sorting results for these are given in Table II. Observers of the sort felt that some unintentional sorter bias occurred at the start, which tended to favor the cured lot of sides. After this initial period, the sort was more objective and, therefore, more representative of the true quality of the material. When this is taken into consideration, the results indicate little or no difference in grade between the two lots.

Sampling

Immediately after blue sort, butt samples were taken from 18 preselected

TABLE II
BLUE SORT RESULTS

Grade*	Numbers of Sides: Cured	Uncured
A	11	6
B	65	64
C	148	158
D	28	24
	252	252

*Letter grades relate to the percentage of the area of the side which is free of blemishes; A signifies the highest, D the lowest.

(randomly by number) pairs of sides for testing and analysis (8). This represents six percent of the total and consisted of equal numbers of cured and uncured sides and of right and left sides. The sampling was random, without regard to side characteristics. These same 18 pairs of sides were again sampled in an adjacent area in the crust.

All of the data obtained from these 18 pairs of matched sides were analyzed statistically by use of the Student's t test to indicate the significance of differences between lots.

Chemical Analyses

The results of the chemical analyses and the shrinkage temperature measurements are given in Table III. With the exception of the crust leather extractables (last column), these data were all obtained from the wrung unsplit blue stock (9).

The pH (10) of the two lots was the same; the overall average was 3.05. The average fat contents (11) of the two lots were also close and the overall average was 5.26 percent (on a moisture-free basis). Thus, curing has no apparent effect on the fat content of the stock at this stage of processing. There was a wide variation in fat content, ranging from 1.96 percent to 11.39 percent, but the variation was on a hide-to-hide basis. The ash contents (12) of both lots were high and that for the uncured lot was significantly higher than that for the cured lot. The overall high ash contents reflect the type of tannage used.

The blue stock from the uncured lot had a significantly higher chrome content (13) than did the blue stock from the cured lot, in spite of the fact that the former lot of sides was offered less tanning agent on a hide-substance basis. The reason for the difference in amount of tanning agent offered has already been discussed in the section on processing. The difference in the shrinkage temperatures for the blue stock from the two lots was also highly significant in favor of the uncured sides. Tanners processing fresh hides can apparently use less tanning

TABLE III

CHEMICAL ANALYSES AND SHRINKAGE TEMPERATURE MEASUREMENTS*

Hide #	Side† (R or L)	Treatment** (C or U)	pH	Fat (%)	Ash (%)	Cr_2O_3 (%)	T_s (°C.)	Extractables (%)
8	L	C	3.0	3.36	14.03	4.04	100	8.31
	R	U	3.1	3.22	14.74	4.12	105	7.14
27	L	U	3.1	9.10	14.75	3.94	106	8.66
	R	C	3.0	8.75	13.84	3.57	100	10.10
42	L	C	3.0	5.96	13.44	3.56	101	7.74
	R	U	3.1	6.62	14.99	3.91	106	9.76
57	L	U	3.0	11.39	13.96	3.82	106	9.23
	R	C	3.1	9.41	13.31	3.64	101	9.37
72	L	C	3.0	2.93	12.84	3.68	101	7.94
	R	U	3.0	2.18	14.31	4.12	106	7.08
A2	L	C	3.0	5.63	13.25	3.68	101	5.85
	R	U	3.1	3.39	15.42	4.05	107	7.63
B5	L	U	3.0	2.36	15.30	3.90	107	9.42
	R	C	3.1	3.07	13.86	3.53	100	7.87
D2	L	C	3.1	6.05	12.57	3.87	101	8.34
	R	U	3.1	5.73	14.62	4.08	107	8.77
E7	L	U	3.1	5.85	15.89	3.87	107	9.60
	R	C	3.0	6.26	12.78	3.46	100	8.28
G2	L	C	3.0	5.06	12.59	3.72	101	7.40
	R	U	3.1	3.73	15.76	4.12	107	8.40
I1	L	U	3.1	9.21	14.26	4.24	107	10.57
	R	C	3.0	9.88	12.44	2.98	98	9.51
J1	L	U	3.1	3.87	16.24	4.01	105	9.08
	R	C	3.0	3.17	15.94	3.91	101	8.48
M1	L	U	3.1	3.71	16.07	4.08	107	6.99
	R	C	3.0	2.50	14.55	3.73	98	9.13
N6	L	C	3.0	1.96	14.46	4.00	101	9.57
	R	U	3.1	2.39	16.08	4.03	106	8.16
R1	L	U	3.0	2.59	15.52	4.00	107	7.31
	R	C	3.0	2.56	13.84	3.80	101	7.04
S4	L	C	3.0	3.18	15.05	3.70	102	9.38
	R	U	3.1	2.94	16.56	3.95	106	8.33
U1	L	U	3.0	10.04	12.82	3.68	106	8.01
	R	C	3.1	7.58	12.46	3.58	102	7.36
W6	L	C	3.1	8.63	13.36	3.70	101	9.37
	R	U	3.0	4.37	15.96	4.01	107	9.33
Avg.		C	3.0	5.36	13.59	3.68	101	8.39
Avg.		U	3.1	5.15	15.18	4.00	106	8.53
t			1.97	0.36	8.12‡	5.13‡	16.11‡	0.11

*From wrung, unsplit blue stock with exception of extractables (chloroform) which is from split crust leather. Analyses are reported on a moisture-free basis.

†Side refers to right (R) or left (L).

**Treatment refers to whether side has been cured (C) or uncured (U).

‡Statistically significant at the 99.9 percent level of reliability according to Student's t test. Positive values of t favor uncured lot.

agent, expect a higher consumption of the tanning agent by the stock, and be reasonably certain that their product will be well tanned. A further consequence of processing uncured hides that is indicated by these results would be the expectation of finding less tanning agent in the tannery effluent.

The analyses for chloroform extractables of the crust stock showed no real difference between the two lots and very little difference between individual pairs of sides. The splitting, fatliquoring, and other post-tanning operations had a leveling effect on the fat content that was so variable in the blue stock.

Microscopical Evaluations

Cross sections of the blue stock were prepared on the freezing microtome and examined according to recommendations by Tancous (14) for evaluating processing effects. Incinerated sections for showing the uniformity of chrome penetration revealed consistently good ash patterns in every sample, indicating no difference between lots in this respect. Untreated sections were carefully examined for the depth to which the fibers had been opened up during processing. This depth was measured (mm.) and expressed as percent of total thickness. Average values for the two lots ranged from about 46 percent to 47.5 percent and again showed no significant difference. Other sections stained for fat with Oil Red O indicated large variations in natural fat between hides but little or no difference between matched sides, and these observations are consistent with the analytical results. Fiber orientation was also evaluated in all preparations to detect the presence of the vertical fiber defect (15) in order to explain any extreme weakness in the physical tests. One pair of sides (W6) gave the typical appearance of this defect as reflected by the physical test results described below.

Physical Tests

The data from the physical tests on the wrung, unsplit blue stock are contained in Table IV. These three tests — tensile strength (parallel to backbone), ball-burst strength, and needle penetrometer strength — were all determined by prescribed or previously described procedures (16, 17, and 18, respectively). On the basis of these results there are some significant differences between the two lots. The stock made from the uncured sides was stronger than that made from the cured sides according to the results of two tests. The tensile strength was higher by nine percent and the needle penetrometer strength was higher by 13 percent. There was a 13 percent difference in the ball-burst extensions of the two lots in favor of the cured lot, but this difference disappeared in the crust leather. The small difference in ball-burst strength between the two lots was not significant. The last pair of sides (W6) listed in this table was identified as having vertical fiber defect (see above) although their strength at this stage was only slightly below average.

The data from the same three physical tests on the crust leather are contained in Table V. The differences (four to five percent) found in the thickness of the

TABLE IV

RESULTS OF PHYSICAL TESTS ON WRUNG UNSPLIT BLUE STOCK

			Tensile Strength				Ball-Burst Strength				Penetrometer Strength	
Hide #	Side (R or L)	Treat. (C or U)	Thick. (in.)	Elong. (%)	Load (lbs.)	Strength (p.s.i.)	Thick. (in.)	Ext. (in.)	Load (lbs.)	Strength (lbs./in.)	Load (lbs.)	Strength (lbs./in.)
8	L	C	.231	48	429	3715	.230	.545	603	2620	37	161
	R	U	.209	45	441	4220	.225	.465	570	2540	39	173
27	L	U	.223	48	347	3110	.225	.480	452	2010	34	151
	R	C	.249	53	307	2465	.214	.470	430	2010	29	136
42	L	C	.198	45	403	4070	.253	.410	523	2065	36	142
	R	U	.247	45	410	3320	.259	.420	556	2145	43	166
57	L	U	.228	49	370	3245	.244	.460	470	1925	38	156
	R	C	.242	50	362	2990	.241	.650	510	2115	34	141
72	L	C	.245	45	298	2435	.240	.500	450	1875	31	129
	R	U	.221	44	350	3165	.226	.425	447	1980	41	181
A2	L	C	.258	48	346	2680	.264	.490	490	1855	37	140
	R	U	.251	46	400	3185	.240	.410	480	2000	40	167
B5	L	U	.301	50	367	2440	.279	.510	551	1975	46	165
	R	C	.266	46	375	2820	.276	.515	531	1925	40	145
D2	L	C	.221	50	341	3085	.243	.555	540	2220	35	144
	R	U	.214	49	379	3540	.227	.475	438	1930	38	167
E7	L	U	.265	54	259	1955	.255	.430	380	1490	36	141
	R	C	.258	54	323	2505	.282	.520	535	1895	40	145
G2	L	C	.264	45	258	1955	.285	.540	506	1775	37	130
	R	U	.232	55	340	2930	.243	.485	486	2000	39	160

TABLE IV *(Continued)*

Hide #	Side (R or L)	Treat. (C or U)	Tensile Strength Thick. (in.)	Tensile Strength Elong. (%)	Tensile Strength Load (lbs.)	Tensile Strength Strength (p.s.i.)	Ball-Burst Strength Thick. (in.)	Ball-Burst Strength Ext. (in.)	Ball-Burst Strength Load (lbs.)	Ball-Burst Strength Strength (lbs./in.)	Penetrometer Strength Load (lbs.)	Penetrometer Strength Strength (lbs./in.)
I1	L	U	.285	49	331	2320	.285	.500	514	1805	42	147
	R	C	.261	49	351	2690	.268	.500	551	2055	39	146
J1	L	U	.220	45	388	3525	.221	.425	454	2055	38	172
	R	C	.220	47	351	3190	.298	.575	560	1880	38	128
M1	L	U	.225	48	347	3085	.241	.455	520	2160	41	170
	R	C	.235	50	308	2620	.238	.560	560	2355	37	155
N6	L	C	.234	44	400	3420	.242	.475	515	2130	38	179
	R	U	.232	35	393	3390	.236	.360	491	2085	43	182
R1	L	U	.201	45	358	3560	.208	.465	500	2405	36	173
	R	C	.262	44	400	3055	.205	.480	501	2445	32	156
S4	L	C	.269	39	499	3710	.268	.525	628	2345	41	153
	R	U	.232	46	450	3880	.238	.500	551	2315	39	164
U1	L	U	.246	48	536	4360	.279	.470	651	2335	47	169
	R	C	.243	54	444	3655	.255	.485	460	1805	35	137
W6	L	C	.249	50	222	1785	.234	.500	384	1640	28	120
	R	U	.230	47	278	2415	.242	.430	379	1565	32	132
Avg.		C	.245	48	357	2936	.252	.516	515	2056	36	143
Avg.		U	.237	47	375	3203	.243	.454	494	2040	40	163
t			−.99	−.69	1.75	2.32*	−1.54	−4.72†	−1.18	−.32	4.53†	5.79†

*Statistically significant at the 95 percent level of reliability according to Student's t test.

†Statistically significant at the 99.9 percent level of reliability according to Student's t test. Positive values favor uncured lot; negative, cured lot.

TABLE V

RESULTS OF PHYSICAL TESTS ON 5½ OZ. CRUST STOCK

			Tensile Strength				Ball-Burst Strength				Penetrometer Strength	
Hide #	Side (R or L)	Treat. (C or U)	Thick. (in.)	Elong. (%)	Load (lbs.)	Strength (p.s.i.)	Thick. (in.)	Ext. (in.)	Load (lbs.)	Strength (lbs./in.)	Load (lbs.)	Strength (lbs./in.)
8	L	C	.087	60	121	2780	.090	.470	204	2275	9.0	101
	R	U	.085	55	145	3405	.089	.420	204	2285	11.5	129
27	L	U	.076	58	144	3790	.081	.415	141	1740	8.5	105
	R	C	.093	57	125	2685	.093	.480	154	1650	9.5	102
42	L	C	.091	52	100	2205	.098	.440	161	1645	8.5	87
	R	U	.088	56	112	2545	.089	.395	138	1550	7.0	79
57	L	U	.083	46	128	3105	.085	.455	185	2175	9.0	106
	R	C	.090	48	123	2730	.089	.420	165	1855	8.5	96
72	L	C	.087	58	149	3425	.092	.415	179	1950	9.0	98
	R	U	.084	65	147	3510	.088	.420	139	1580	8.0	91
A2	L	C	.089	53	185	4160	.095	.375	217	2280	13.0	137
	R	U	.088	67	169	3835	.091	.435	177	1940	11.0	121
B5	L	U	.080	53	135	3360	.080	.365	150	1870	8.5	106
	R	C	.084	54	111	2630	.093	.390	149	1610	8.0	86
D2	L	C	.085	51	130	3050	.087	.460	157	1805	9.0	103
	R	U	.089	58	154	3485	.093	.425	151	1630	9.5	106
E7	L	U	.086	54	140	3230	.086	.415	170	1985	10.0	116
	R	C	.091	63	148	3250	.096	.415	146	1525	11.0	115
G2	L	C	.081	56	113	2795	.088	.435	147	1675	8.0	91
	R	U	.079	67	136	3450	.083	.475	138	1665	7.0	84

TABLE V *(Continued)*

Hide #	Side (R or L)	Treat. (C or U)	Tensile Strength: Thick. (in.)	Tensile Strength: Elong. (%)	Tensile Strength: Load (lbs.)	Tensile Strength: Strength (p.s.i.)	Ball-Burst Strength: Thick. (in.)	Ball-Burst Strength: Ext. (in.)	Ball-Burst Strength: Load (lbs.)	Ball-Burst Strength: Strength (lbs./in.)	Penetrometer Strength: Load (lbs.)	Penetrometer Strength: Strength (lbs./in.)
I1	L	U	.076	61	111	2930	.085	.410	156	1835	8.0	98
	R	C	.088	62	94	2140	.093	.425	138	1485	8.0	85
J1	L	U	.083	52	125	2995	.088	.410	184	2090	8.0	94
	R	C	.089	54	137	3070	.089	.405	156	1765	9.0	101
M1	L	U	.082	50	118	2895	.084	.375	158	1885	8.0	96
	R	C	.089	53	105	2360	.092	.405	150	1630	9.0	98
N6	L	C	.092	65	131	2870	.092	.510	174	1890	8.5	92
	R	U	.085	62	124	2920	.091	.415	143	1575	8.5	93
R1	L	U	.085	44	106	2485	.083	.385	145	1750	8.0	96
	R	C	.087	48	98	2255	.090	.380	145	1620	8.0	89
S4	L	C	.086	58	127	2960	.086	.430	153	1775	7.5	87
	R	U	.086	61	141	3300	.086	.395	179	2095	9.0	105
U1	L	U	.088	56	159	3615	.087	.385	192	2210	10.5	121
	R	C	.088	57	130	2970	.090	.400	162	1810	8.5	94
W6	L	C	.089	40	42	935	.089	.410	76	850	5.0	56
	R	U	.086	43	52	1215	.090	.400	70	775	5.0	56
Avg.		C	.088	55	121	2737	.091	.426	157	1728	8.7	95
Avg.		U	.084	56	130	3115	.087	.411	157	1813	8.6	100
t			−3.82†	.76	3.03*	4.51‡	−4.95‡	−1.67	−.14	2.01	−.39	1.58

*Statistically significant at the 99 percent level of reliability. Positive value favors uncured lot.
†Statistically significant at the 99.5 percent level of reliability. Negative value favors cured lot.
‡Statistically significant at the 99.9 percent level of reliability. Positive values favor uncured lot; negative values, cured lot.

crust leather made from the two lots are almost certainly caused by splitting differences. The two lots were split separately and the tolerances involved would allow for a difference of this magnitude. The 13 percent difference in tensile strengths in favor of the crust leather made from the uncured lot was statistically significant. This result has been found generally for leather made from uncured hides (4, 5, 6). The small differences found in the ball-burst and penetrometer data were not statistically significant. The physical strength properties for the pair of sides (W6) found to have vertical fiber defect are considerably lower than the averages (by over 50 percent) in this crust leather.

The water-vapor permeability of leather made from uncured hides has been claimed to be inferior to that made from hides that have had normal curing (5). We have measured this property (19) on the crust leather made from eight sides, including three matched pairs and two unmatched sides. The values obtained from these measurements on the crust leather from the four cured sides averaged 0.00143 gram per square centimeter per hour, with a range of 0.00138 to 0.00154. The corresponding values obtained for the uncured sides were 0.00134 for the average and 0.00128 to 0.00143 for the range. While this amounts to a six percent difference in favor of the cured sides, the difference is not significant statistically ($t = 1.38$) nor is it significant in the effect it would have on the comfort factor associated with wearing shoes made from this leather.

Crust Sort

The crust leather made from the uncured sides was found to be indistinguishable from the crust leather made from the cured sides. Both lots of crust leather had a completely acceptable, fine break. These subjective analyses were made by experienced tannery personnel who had no knowledge of the lot identification of the sides during the sort.

CONCLUSIONS

The results of this study demonstrate that quality side upper leather can be made from uncured hides using a conventional process. The leather obtained was essentially indistinguishable from leather made from matched sides that had been pit-cured. Indeed, the important differences found in the chemical and physical properties favored the leather made from the uncured sides. These conclusions agree with at least one report (4) which has appeared in the literature, but contradict others (5, 6). Processing differences could be responsible for some of these apparent contradictions.

The matched side approach, by avoiding the large variation between hides, provides added significance to any difference found between curing treatments applied to the pairs of sides. However, the variations inherent in different tannery lots, no matter what efforts are made to minimize them, may have influenced the results of this study. Such lot differences may significantly affect the physical properties of leather (20, 21); simultaneous processing would be the only way to avoid this problem. Therefore, despite the trend in favor of the uncured sides, a conservative conclusion of "no essential difference" would be warranted at least.

Certain results of this study indicate that some changes should be made in tannery processes when the raw stock is changed from cured to uncured hides. The nature of these tannery changes is such that they could be economically advantageous. The economic advantages that might be realized as a result of a shorter processing time have been analyzed by Moede and Poats (3). There are implications that additional advantages might be realized as a result of the different reactivity of the uncured hides to liming and tanning. There is the potential for greater chrome utilization by uncured hides and the economic advantages of this are obvious — less chrome can be used for a given degree of tannage and, consequently, less chrome will be disposed of in the effluent.

Data obtained as a part of the study indicate that a greater yield of leather can be obtained from uncured hides than from cured hides that have been processed by the same steps. The economic advantages that would result from this have also been analyzed by Moede and Poats (3). Again, there are contradictory reports in the literature (4, 6) but these may also be due to processing differences. A large hide-to-hide variation in yield was obtained in this study but the overall result was a three percent greater yield in favor of the uncured lot of sides and this was statistically significant.

No basis was obtained from this study on which standards could be established for judging the quality of wrung, unsplit, chrome-tanned stock or crust leather; however, a large volume of information concerning the physical, chemical, and microscopic properties of these samples was accumulated in this study which should be useful in future work on establishing standards.

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DISCUSSION

DR. JAMES M. CONSTANTIN (Pfister and Vogel Tanning Company): As tanners I am certain that all of you can appreciate that this is the kind of test that we would love to be able to run, involving matched pairs of sides from 300 heavy steerhides, with an interested, friendly, and co-operative packer to do the curing for us. Not too many of us have the opportunity to find and work with such a packer. A test like this is fantastic for the data which it can generate.

One thing that must plague us is one of the reasons for the test, namely, the possibility of our being forced into elimination of salt curing by EPA requirements. We have heard several papers on the pressures which may be generated. On this fine Wednesday morning, I would like to offer a ray of hope. I refer to the EPA Draft Development Document, November, 1973, page 3: "The requirement to remove dissolved solids by 1983 is not recommended. The technology for widespread removal of dissolved salts and disposal of concentrated brines is not well defined. Extensive research efforts should be made by the industry to find a substitute for the salt used in hide curing, which is a major contributor of the dissolved solids."

This, of course, we are doing. But the fact is, and we hope that it will remain, that the technology transfer with which we are being saddled will not pertain even by 1983.

Furthermore, in the Preamble to Section 425 of the EPA proposed effluent guidelines for our industry, as published in December, 1973, it says that "no limitations have been established for chemical oxygen demand, total dissolved solids, ammonia nitrogen, or color because available data has indicated these pollutants are normally removed when significant pollutants are removed or they occur in insignificant quantities." Also, further in the Preamble, it is stated that "no discharge of process waste water pollutants would require use of desalination techniques which, at this point in time, are not deemed to be economically achievable for this industry category and also would require an energy consumption increase of approximately 100 percent."

Those of us who have been in contact with Bob Lollar's work with the EPA know how intractable the EPA Standards group is in changing its opinions about our industry. Let us hope that these statements represent the position that they will continue to maintain during the years ahead. Then we can continue to evaluate fresh *versus* cured hides with the goal of making better leather, and not because we are forced to meet effluent strictures due to dissolved solids.

There are certain specific questions about the data contained in the paper which I would like to direct either to Dr. Feairheller or Dr. Holloway:

1 — The cured shrinkage was only 10.8 percent. In our experience, this is about one half of the normal shrinkage which we would expect with prefleshed, demanured hides. What is the implication of this?

2 — The white weight gain for the fresh hides was about 128 percent, while the white weight gain on the cured hides was about 155 percent. While these differences in the white weight gain may indeed be a function of fresh hides *versus* cured hides, they may also be an "accidental" result of the processes used for the fresh *versus* the cured hides.

Dr. S. H. Feairheller (Eastern Regional Research Center): Thanks for the update on the EPA positions. I think that Don Holloway could better answer the questions about the process differences since the processing was done at his tannery.

Dr. Donald F. Holloway (then at Wisconsin Leather Company, now at General Split Corporation): The observed curing shrinkage was low. These hides were pit brine cured with the brine saturation regularly checked. They were loaded onto a truck for shipment on a rainy day with rain falling on the hides also, so that the shrinkage is lower. We realize that there is some bias in the test. Also, they were promptly shipped and processed after thorough curing, so there was less shrinkage from fresh weight to cured than is the normal amount. At this plant we would expect the normal level of shrinkage to be 14 to 16 percent.

Answering the question about processing, after the soak, both lots of sides were put through the beamhouse and the bate-pickle-tan operations by exactly the same process. The only difference was that the fresh sides were not soaked, but were merely washed enough to bring them to the proper temperature. Both lots were paddle limed in a burned hair process with a relime, followed by the conventional and identical processes for both lots. The soaking difference was the only process difference.

DR. CONSTANTIN: There are many in the audience who regularly use cured *versus* fresh hides. Is this the consensus — that you find unusually high white weight gains? We anticipate 125-135 percent weight gain in our white weight gain over cellar weight for brine cured, prefleshed hides. Here we see 155 percent. Is this the consensus of experience, or is it attributable to the processes employed here? (No comments from the audience.)

MR. CLINTON RETZSCH (Nopco-Diamond): Dr. Feairheller, would you care to comment on the fat content of the cured sides *versus* the fresh sides?

DR. FEAIRHELLER: We did of course determine the fat contents of both lots. The variations from hide to hide were much greater than the difference between the two lots.

DR. CONSTANTIN: Mention has been made of yield comparisons. Steve is taking a guarded position, which I think is a wise one, about the increase in area yields. Don, do you remember what the split weight averages were from the two lots? I presume that you made either HH weight grain leather, or 5.5 to six ounce leather from these sides. Did you split off a heavier split from the cured sides than you did from the fresh sides, which could also have quite an influence on both yield and the leather physical characteristics?

DR. HOLLOWAY: The split weights were not taken. At that time the normal practice which was followed in this test was to split all stock one-half ounce heavier than the shaved weight. All the leather was split to six ounces and then shaved to 5.5 ounces on the blue stock.

MR. ALBERT S. JAMISON (Seton Leather Company): What was the degree of saturation in the brines which you used during curing?

DR. HOLLOWAY: Don't forget that these were pit cured hides. I have been asked why pit curing was chosen when both methods were available. We chose pit curing, which was the standard practice at Spencer, Iowa, because we were curing sides. We wished to avoid rolling of the sides which would result in brine raceways. The brine saturation in the pit is well in excess of 85 percent saturation.

DR. CONSTANTIN: Why were only six pairs of matched sides tested in the hide storage test?

DR. FEAIRHELLER: More matched pairs were stored, approximately 40 pairs total. Groups were removed at various periods of time during the storage period.

These groups were removed during the three to six month period, with groups of six being randomly selected. We felt that six at a time was a representative sample.

MR. SATYENDRA M. DE (Chestnut Operating Company): Generally more albumins and globulins are removable in the beamhouse from cured hides than from uncured hides. Your results showed equal leather quality. Does this mean that the albumin and globulin content did not make any difference in your system?

DR. FEAIRHELLER: We have not seen any difference to date. Since there is background literature to the effect that uncured hides yield leather with lower water vapor permeability than does leather from cured hides, we are running water vapor permeability tests. This effect has been interpreted to mean that the albumins and globulins remain in the leather from uncured hides, and clog the leather pores, resulting in lower permeability. The water vapor permeability data will be in the published paper.

DR. CONSTANTIN: Don, what is crust stock in your tannery?

DR. HOLLOWAY: This is all full grain leather, with no extract in it. It was washed after pasting, conditioned, and staked on a Mollisa staker, and then was ready for finishing.

MR. S. S. SARYAN (Wolverine World Wide): Dr. Feairheller, would you be willing to furnish me with samples for water vapor simultaneous absorption and permeability tests from your crust leather to confirm your tests?

DR. FEAIRHELLER: Yes, I think there will be enough leather available.

MR. STEPHEN A. SHIVAS (Barrie Tanning Ltd.): On behalf of the Association, Steve, I would like to present you with the Association's Certificate of Appreciation for a most interesting study carried out by you and your co-workers.